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ABSTRACT

This study looks at the correlates of mathematics anxiety in female college freshmen through an examination of the following: (1) the correlation between mathematics anxiety and mathematics achievement; (2) the correlation between anxiety and attitudes; (3) the correlation between the number of mathematics courses taken in high school and anxiety; and (4) the relationship between the mother's and father's occupations and mathematics anxiety. Subjects for the study consisted of 377 female students at a small, private women's liberal arts college in the Midwest. Mathematics achievement was measured using a multiple choice test constructed by faculty members in the college's Mathematics Department. Among the results: (1) the relationship between mathematics achievement and anxiety is negatively correlated; (2) less mathematics-anxious subjects have more confidence in their ability to learn than more mathematics-anxious subjects; (3) mathematics anxiety was significantly related to scores on the Usefulness of Mathematics scale; (4) the relationship between anxiety and number of courses taken in high school has a significant positive correlation; and (5) parents' occupation is not a factor in subjects' math anxiety. (MP)

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CORRELATES OF MATH ANXIETY IN FEMALE COLLEGE FRESHMEN

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Competence in mathematics is a prerequisite for success in a variety of jobs in technical fields, scientific fields, business and social sciences. However, millions of Americans purposefully avoid any and all encounters with mathematics because they experience a phenomenon labelled math anxiety. Richardson and Suinn (1972) define math anxiety as "feelings of tension and anxiety that interfere with manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (p. 551). Women, more than men, appear to suffer from math anxiety and its subsequent negative impact on their education and career decisions. Tobias (1976) discusses math anxiety as being rooted in "...a culture that makes mathematic ability a masculine attribute, that punishes women for doing well in mathematics, and that soothes the slower mathematics learner by telling her she does not have a "mathematics mind" (p. 57).

Mathematicians and psychologists have just begun to develop counseling strategies to reduce math anxiety. Even less progress has been made toward defining the variables associated with math anxiety, such as subjects' attitudes,

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family background, academic achievement, and educators' expectations. Betz (1978) is one of the few researchers to study the relationship between math anxiety and the variables of math attitudes and high school preparation. An adequate definition of math anxiety requires a follow-up to Betz' study including an examination of the relationship between math anxiety and other demographic and personality variables.

This study attempts to look at the correlates of math anxiety in female college freshmen. More specifically, we have examined a) the correlation between math anxiety and math achievement; b) the correlation between math anxiety and math attitudes; c) the correlation between the number of math courses taken in high school and math anxiety; and d) the relationship between mother's and father's occupations and math anxiety.

METHOD

Subjects:

The subjects for the study consisted of 377 female college freshmen enrolled at a small, private women's liberal arts college in the Midwest. All subjects were tested as part of the college's regular placement testing program prior to the Fall semester of the 1978-79 academic year. Thirty-three subjects' test results were eliminated from the study because of incomplete demographic data, leaving 344 for data analysis.

Instrumentation:

Mathematics achievement was measured using a 50-item multiple choice test constructed by faculty members in the Mathematics Department at the College. Test validity was determined by having five members of the mathematics faculty

reach 100% agreement on matching items to objectives. The test reliability was computed to be 0.93 using the Kuder-Richardson 21.

Attitudes toward mathematics were measured using seven scales developed by Fennema and Sherman (1976): Confidence in Learning Mathematics, Mother Scale, Father Scale, Teacher Scale, Attitude Toward Success in Mathematics, Mathematics as a Male Domain, and Usefulness of Mathematics. Math anxiety was measured using a scale also developed by Fennema and Sherman (1976). The attitudes scales and the math anxiety scale each contain 12-items. Item responses were obtained on a 5-point Likert scale with responses ranging from 1 (strongly agree) to 5 (strongly disagree). Half of the items were positively worded and the other half, negatively worded. Scoring of the negatively-worded items was reversed so that a low score on a particular scale reflected either positive attitudes toward mathematics or less math anxiety.

Procedure:

The students were administered the instruments in a group situation. All students were allowed unlimited time to complete the battery of tests. Each student ranked her responses to the instruments on a computer scoring sheet. The data were analyzed using an SPSS program (1970) for Pearson product-moment correlation, analyses of variance, and analyses of covariance.

RESULTS

Means, ranges, and standard deviations for scores of the 344 female college freshmen on the mathematics achievement test, the Mathematics Attitude Scales and the Mathematics Anxiety Scale are reported in Table 1.

The relationship between mathematics achievement and math anxiety was found

to be negatively correlated (r= -0.2027). High math-anxious subjects exhibited less competence in mathematics knowledge than subjects with less math anxiety.

Reported in Table 2 are the Pearson product-moment correlation coefficients between the scores on the Mathematics Attitude Scales and the Mathematics Anxiety Scale. Math anxiety was found to be significantly related to scores on the Confidence in Learning Mathematics Scale (r= 0.3932). Less math-anxious subjects had more confidence in their ability to learn mathematics than more math-anxious subjects. Correlations between subjects' math anxiety and teachers' perceived attitudes toward mathematics were higher (r= 0.3515) than were those between subjects' math anxiety and either the fathers' perceived attitudes toward mathematics (r= 0.2420), or the mothers' perceived attitudes toward mathematics (r= 0.1041). Subjects' math anxiety scores were negatively correlated with scores on the Attitude Toward Success in Mathematics Scale (r= -0.1746) and Mathematics As A Male Domain Scale (r= -0.3262). Math anxiety was significantly related to scores on the Usefulness of Mathematics Scale (r= 0.2626). Less math-anxious subjects viewed mathematics as more useful than did high mathematics anxious subjects.

The relationship between anxiety and number of mathematics courses taken in high school for the group of 344 female college freshmen was significantly correlated (r= 0.3158). An analysis of covariance on math anxiety scores for high- and low-anxious subjects using total number of high school mathematics courses as the covariate is reported in Table 3. Results indicated that there were significant differences between high- and low-anxious subjects when the effect of total number of high school mathematics courses was removed.

Reported in Table 4 are the means, ranges, and standard deviations for subjects' scores on the math anxiety scale by the math-relatedness of parents' occupations. In Tables 5-10, the results of analyses of variance for all possible paired comparisons of parents' occupation are reported. The results indicated that parents' occupation (math-related or non-math-related) was not a factor in subjects' math anxiety.

DISCUSSION AND CONCLUSION

The results of the study indicate that math anxiety has a detrimental effect on achievement in mathematics. The data showed that as anxiety about matnematics increased, achievement in mathematics decreased. These results are consistent with Betz (1978) who also found that math anxiety was negatively correlated with mathematics achievement.

Subjects' attitudes toward mathematics were found to be correlated with math anxiety. Attitudes toward confidence in one's ability to learn mathematics and toward the usefulness of mathematics appear to be affected by one's level of math anxiety. This is again consistent with Betz' research. An unanticipated finding was the negative correlations between subjects' mathematics anxiety and their attitudes toward mathematics as a male domain and toward success in mathematics. These findings are not in agreement with Betz who found a non-significant correlation between subjects' math anxiety and scores on the Math As A Male Domain Scale. This difference may be explained in part by comparing the characteristics of the subjects in this study with Betz' sample. Her subjects were students who were more sophisticated mathematically and perhaps adhered less to a traditional female role definition than the students in the present study. The Math 2 group in Betz' study consisted of students who had elected pre-medicine,

engineering or mathematics. The present study consisted of students most of whom were pursuing non-mathematical careers at a liberal arts college and may, therefore, have adhered to the traditional societal view that mathematics is a male pursuit. This may also explain the negative correlation between math anxiety and attitudes toward success in mathematics.

Perceived teacher attitudes toward mathematics had a stronger influence on subjects' math anxiety than the perceived attitudes of either parent although it is not clear to which teacher or group of teachers the subjects were referring.

The effect of number of high school mathematics courses on math anxiety is strong and positive and consistent with Betz' research. The more mathematics courses in high school a subject took, the less was her anxiety toward mathematics. It is not clear if enrolling high school students in mathematics courses reduces anxiety toward mathematics or if students who enroll in more mathematics courses in high school have less initial math anxiety. An analysis of covariance, with number of high school mathematics courses as the covariate, indicates that factors other than high school mathematics background are operating to cause a difference in math anxiety between high- and low-anxious subjects.

Whether the parents' occupations are or are not math-related had no effect on the subjects' math anxiety. This is contrary to the expectation that mothers working in math-related jobs would have a strong influence on their daughters' math anxiety and attitudes toward mathematics.

The findings in this study lead us to make recommendations for futher research on the correlates of math anxiety and for the continued development of counseling methods for overcoming math anxiety. The nature of the influence of perceived teacher attitudes toward mathematics on students' math anxiety is one

area needing further refinement. The question of which teachers have what influence at which stage of a student's education is key. Comparing students' perceptions at different points in the curriculum with a more refined instrument will help us know how to prepare teachers to be more sex-fair in their interactions with students regardless of mathematics interest and achievement. Secondly, we need to examine the influence of sex role socialization on students' attitudes toward mathematics. For example, what influence will adherence to a traditional or androgynous sex role have on perceptions of math as a male domain or attitudes toward one's own success in mathematics? The interaction of sex role and math attitudes is likely to influence the level of math anxiety in individuals, especially female students, and should be carefully studied.

While the development of math anxiety treatment programs is well underway (Tobias & Melmed, 1980), our research suggests that such programs need to include a consciousness-raising component in addition to the focus on anxiety reduction and math content that currently exists. This would help overcome the tendency in female students especially to view math as a male domain or to consider mathematics as an irrelevent area for successful achievement. Not only would it be important to make students aware of successful female mathematicians who could be potential role models, but counselors and math teachers should consider a program that incorporates reports from students who are peers of their math-anxious counterparts and who could describe their own experiences of overcoming math anxiety. This kind of peer exchange could hopefully further eliminate the view of math as a male or irrelevant domain.

Table 1

Means, Ranges and Standard Deviations for Mathematics Achievement, Attitudes Toward Mathematics, Mathematics Anxiety and Total Number of High School Mathematics Courses of Female College Freshmen Students

Variable	N	Mean	Range	SD
Mathematics Achievement	344	36.8	36.0	8.41
Mathematics Attitudes	344			
Confidence in Learning Mathematics		35.6	47.0	9.16
Mother's Perceived Attitudes		34.0	38.0	6.40
Father's Perceived Attitudes		34.1	47.0	7.02
Teacher's Perceived Attitudes		36.1	43.0	7.06
Attitude Toward Success in Mathematics		33.2	42.0	8.30
Mathematics as a Male Domain		29.3	44.0	10.00
Usefulness of Mathematics		33.1	37.0	6.70
Mathematics Anxiety	344	36.9	48.0	8.76
Total Number of High School Mathematics Courses	344	3.3	9.0	1.48

Table 2

Relationship Between Mathematics Anxiety and Mathematics Attitudes and Total Number of High School Mathematics Courses for Female College Freshmen Students

Variable	Mathematics Anxiety	
	N	r
Mathematics Attitudes	344	
Confidence in Learning Mathematics		0.3932**
Mother's Perceived Attitudes		0.1041*
Father's Perceived Attitudes		0.2420**
Teacher's Perceived Attitudes		0.3515**
Attitude Toward Success in Mathematics		-0.1746**
Mathematics as a Male Domain		-0.3262**
Usefulness of Mathematics		0.2626**
Total Number of High School Mathematics Courses		0.3158**

*$p < .05$
**$p < .001$

Table 3

Analysis of Covariance of Scores on The Mathematics Anxiety Scale for High- and Low-Anxious Female College Freshmen Students

Source of Variation	Sum of Squares	df	Mean Square	F
Covariates				
Number of High School Math Courses	2625.572	1	2625.572	97.95*
Main Effects				
Anxiety	14560.984	1	14560.984	543.23*
Explained	17186.559	2	8593.277	
Residual	9140.207	341	26.804	
Total	26326.766	343	76.754	

*$p < .001$

Table 4

Means, Ranges and Standard Deviations of Scores on The Mathematics Anxiety Scale by Math-Relatedness of Parents' Occupation for Female College Freshmen Students

Group	N	Mean	Range	SD
Father(Math-Related) Mother(Math-Related)	83	36.96	48.00	9.35
Father(Not Math-Related) Mother(Not Math-Related)	55	36.46	34.00	7.97
Father(Math-Related) Mother(Not Math-Related)	114	37.54	46.00	9.29
Father(Not Math-Related) Mother(Math-Related)	18	38.5	33.00	8.43

Table 5

Analysis of Variance of Scores on The Mathematics Anxiety Scale by Parent Occupation (Father(Math-Related)-Mother(Math-Related)) X (Father(Not Math-Related)-Mother(Not Math-Related))

Source of Variation	Sum of Squares	df	Mean Square	F
Main Effects	8.581	1	8.581	0.110*
Parents' Occupation				
Explained	8.582	1	8.582	
Residual	10594.348	136	77.900	
Total	10602.930	137	77.394	

*$p > .05$

Table 6

Analysis of Variance of Scores on The Mathematics Anxiety Scale by Parent Occupation (Father(Math-Related)-Mother(Math-Related)) X (Father(Math-Related)-Mother(Not Math-Related))

Source of Variation	Sum of Squares	df	Mean Squares	F
Main Effects	15.673	1	15.673	0.671*
Parents' Occupation				
Explained	15.676	1	15.676	
Residual	16916.914	195	86.753	
Total	16932.590	196	86.391	

*$p > .05$

Table 7

Analysis of Variance of Scores on The Mathematics Anxiety Scale by Parent Occupation (Father(Math-Related)-Mother(Math-Related)) X (Father(Not Math-Related)-Mother(Math-Related))

Source of Variation	Sum of Squares	df	Mean Square	F
Main Effects	34.905	1	34.905	0.522*
Parents' Occupation				
Explained	34.906	1	34.906	
Residual	8375.262	99	84.599	
Total	8410.168	100	84.102	

*P > .05

Table 8

Analysis of Variance of Scores on The Mathematics Anxiety Scale by Parent Occupation (Father(Not Math-Related)-Mother(Not Math-Related)) X (Father(Math-Related)-Mother(Not Math-Related))

Source of Variation	Sum of Squares	df	Mean Square	F
Main Effects	43.318	1	43.318	0.460*
Parents' Occupation				
Explained	43.320	1	43.320	
Residual	13177.707	167	78.908	
Total	13221.027	168	78.697	

*$P > .05$

Table 9

Analysis of Variance of Scores on The Mathematics Anxiety Scale by Parent Occupation (Father(Not Math-Related)-Mother(Not Math-Related)) X (Father(Not Math-Related)-Mother(Math-Related))

Source of Variation	Sum of Squares	df	Mean Square	F
Main Effects	56.740	1	56.740	0.354*
Parents' Occupation				
Explained	56.742	1	56.742	
Residual	4636.109	71	65.297	
Total	4692.852	72	65.178	

*p > .05

Table 10

Analysis of Variance of Scores on The Mathematics Anxiety Scale by Parent Occupation (Father(Math-Related)-Mother(Not Math-Related)) X (Father(Not Math-Related)-Mother(Math-Related))

Source of Variation	Sum of Squares	df	Mean Square	F
Main Effects	14.474	1	14.474	0.679*
Parents' Occupation				
Explained	14.477	1	14.477	
Residual	10958.664	130	84.297	
Total	10973.141	131	83.764	

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